IKONOS Derived Inputs for Precision Farming

High Spatial Resolution Commercial Workshop, March 19-21, 2001. Greenbelt, MD

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Upper Midwest Aerospace Consortium

Delivering Information from Space to the Public

USFS Region 1

USFS Fire Sciences Lab

Potlatch Corporation

Boise Cascade

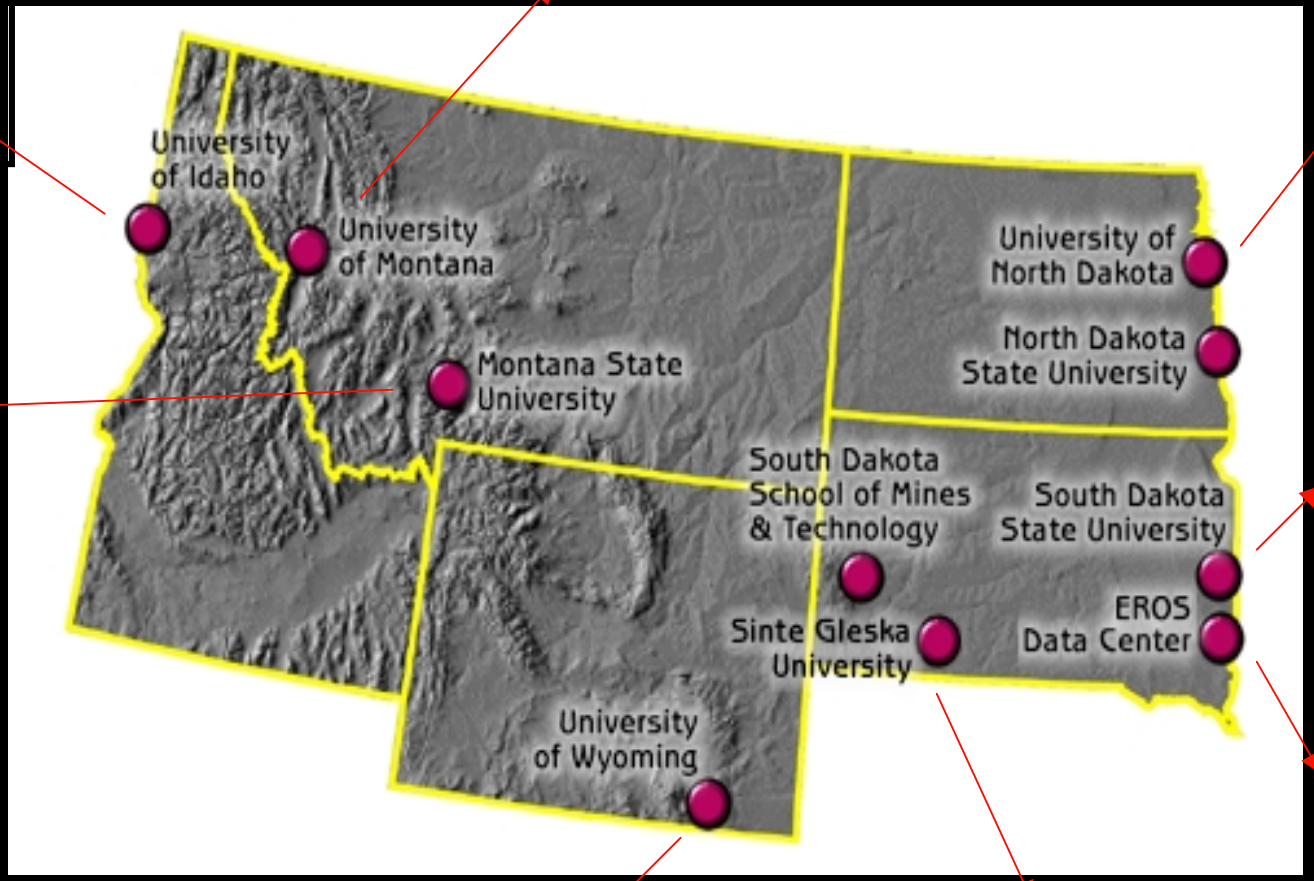
Plum Creek Timber Co.

Precision Agriculture Research Association

Montana Watershed Inc.

Triangle Agriculture – Services, LLC

Yellowstone National Park



Manitoba – North Dakota Zero-Tillage Association

American Crystal Sugar

Dakota Pasta Growers

Spring Wheat Bakers

Prairie Public TV

National Education Television Association.

SD Precision Agriculture Association

Satellite and aerial data

K-12 Education

The Nature Conservatory

BLM

Wyoming Cattlemen's Association

Rosebud Sioux Reservation

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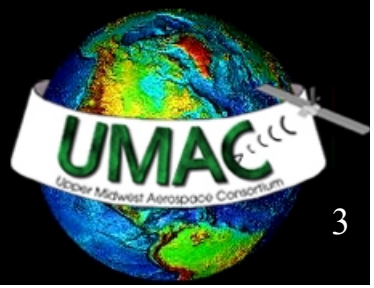
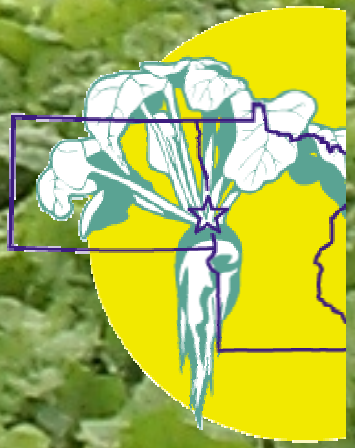
ACKNOWLEDGEMENTS

- Precision Sugarbeet Farmers of North Dakota
- Especially Pete Carson, Robert Green and Gary Wagner
- American Crystal Sugar Company
- NASA's Scientific Data Purchase Program
- NASA Grants NAG-3616 and NCC-310
- My Colleagues at UMAC
- Students

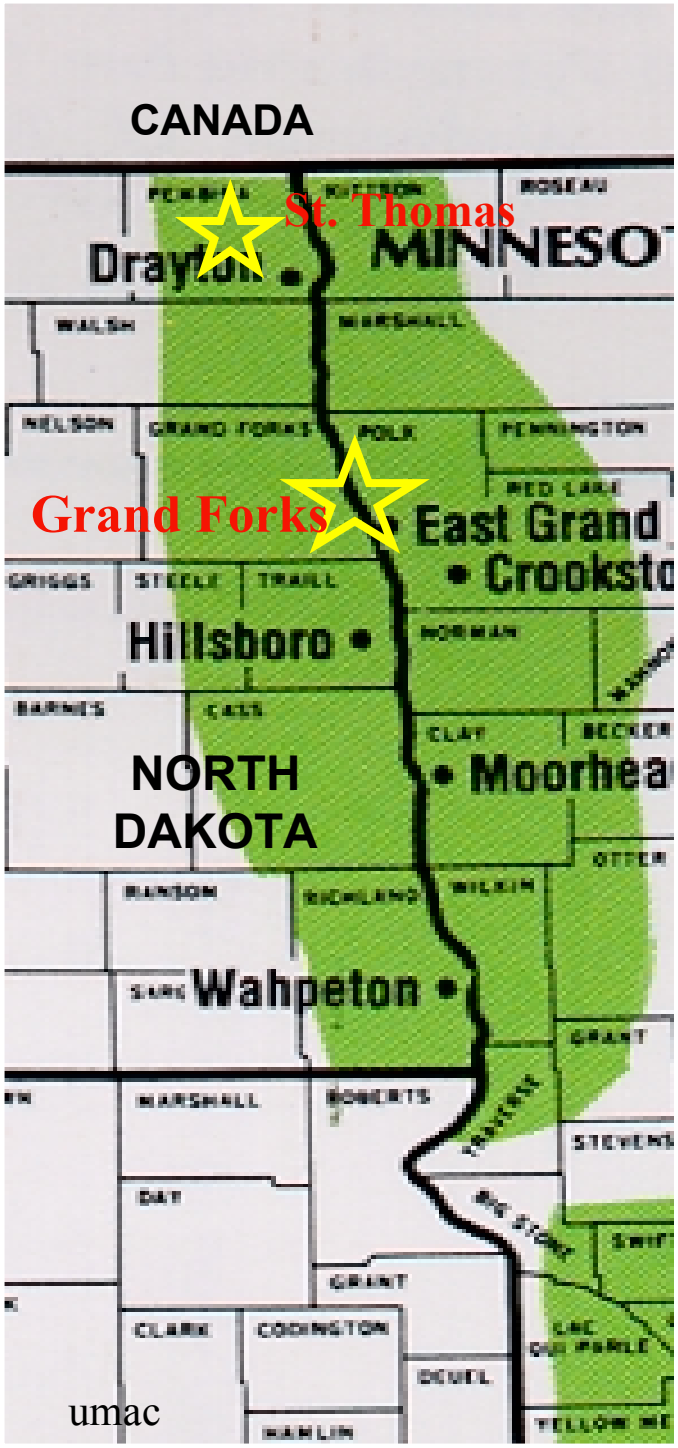


The beet industry in Red River Valley

- **Two billion dollar industry**
- **US produced 30 million tons, 1.46 million acres were planted (1997)**
- **The Red River Valley in MN & ND produced 12.2 million tons, 0.684 million acres were planted (1997)**



- **Any input to support precision farming, and managing stress due to weeds, insects, wet soil conditions/flooding, wind damage and uneven distribution of soil nutrients, will improve productivity and income.**


CANADA
St. Thomas
Drayton
MINNESO
Grand Forks
East Grand
Crookston
Hillsboro
NORTH
DAKOTA
Moorhead
Wahpeton
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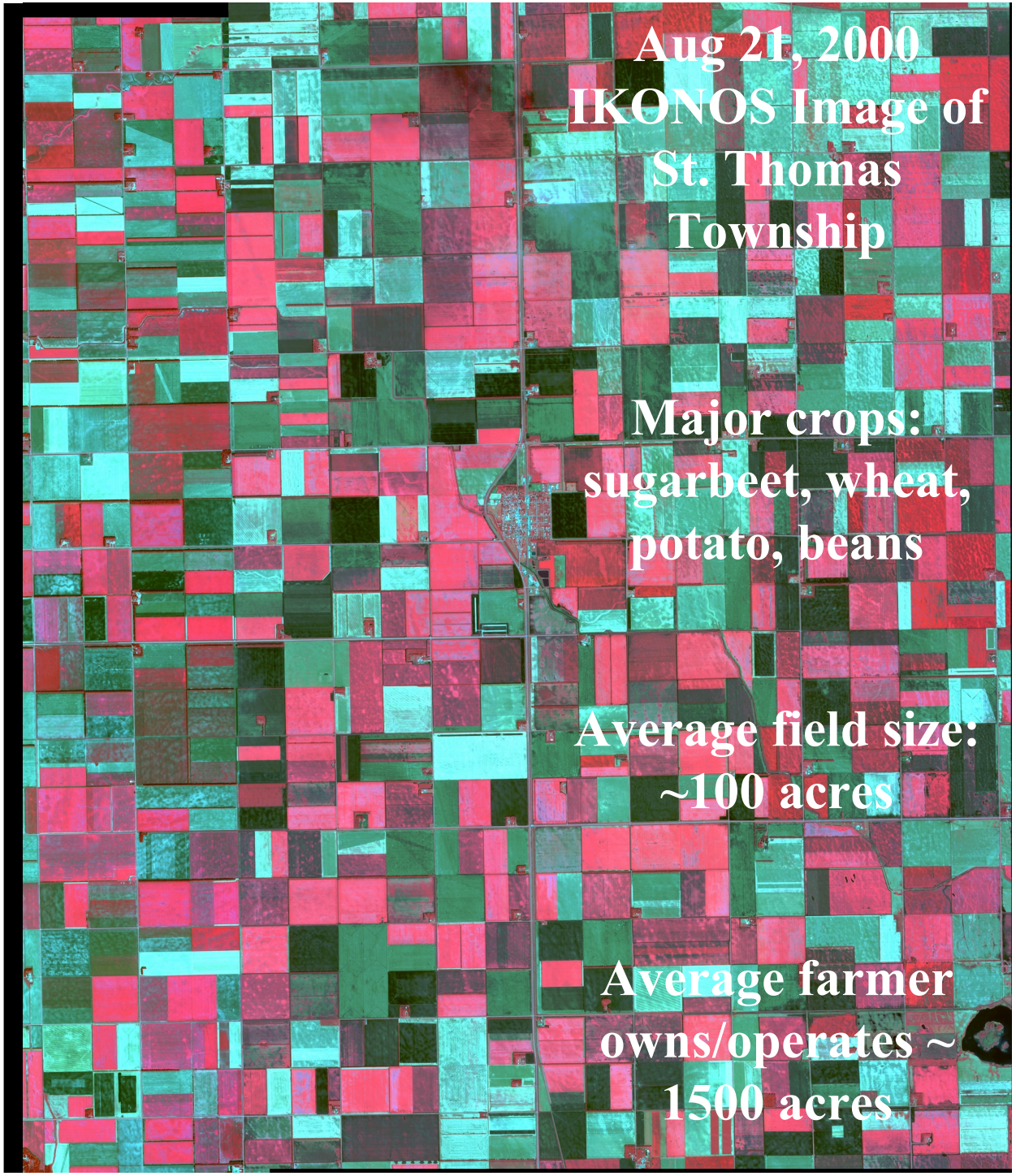
Aug 21, 2000
IKONOS Image of
St. Thomas
Township
Major crops:
sugarbeet, wheat,
potato, beans
Average field size:
~100 acres
Average farmer
owns/operates ~
1500 acres

5 Applications of IKONOS Imagery for Precision Farming

- Zoning for variable rate fertilizer application
- Using Ikonos imagery to monitor nitrogen application on sugarbeet fields
- A comparison of Ikonos imagery with wheat yield data on a fungicide test site.
- Using NDVI to select acres of sugarbeets to destroy for Payment In Kind (PIK)
- Desiccant damage assessment


Zoning for variable rate fertilizer application
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Oblique aerial photograph
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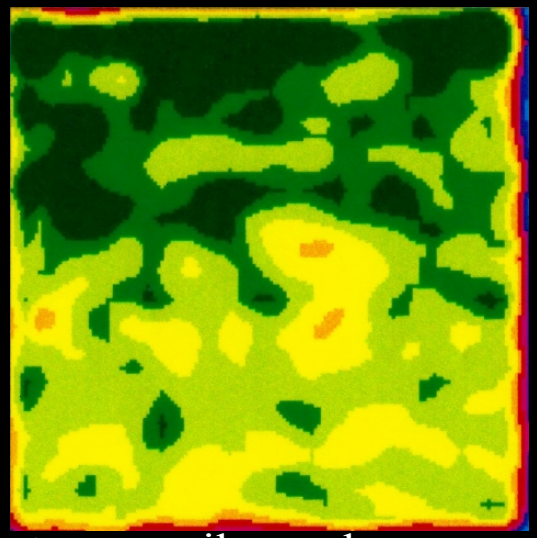
Imagery Based Zoning

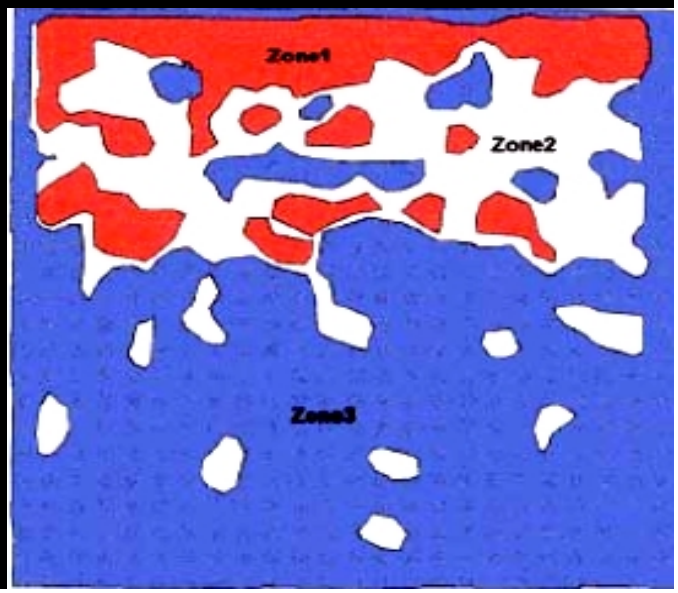
90 31	90 30	90 19	0 18	50 7	20 6
90 32	10 29	106 20	113 17	40 8	90 5
90 33	40 28	20 21	80 16	112 9	90 4
60 34	80 27	0 22	35 15	60 10	50 3
80 35	40 26	50 23	60 14	40 11	80 2
80 36	25 25	80 24	70 13	0 12	60 1

Original grid based soil sampling – larger, handwritten numbers indicate recommended amount of fertilizer application in pounds of nitrogen

one soil sample per grid. Cost $13.49 per acre



Satellite imagery of field 789 SE ¼ section 29 159-53, St. Thomas, North Dakota acquired on Aug 14, 1999. Field size: 151 acres



Zoning based on imagery – reduces to one soil sample per zone and the cost to $2.66 per acre. Recommended fertilizer application: zone 1 = no application, zone 2 = 72 pounds of nitrogen, zone 3 = 53 pounds of nitrogen.

Cost saving in survey: $10.83 per acre.

Additional savings in fertilizer cost: $3.84 per acre.

Total cost saving: $14.67 per acre.

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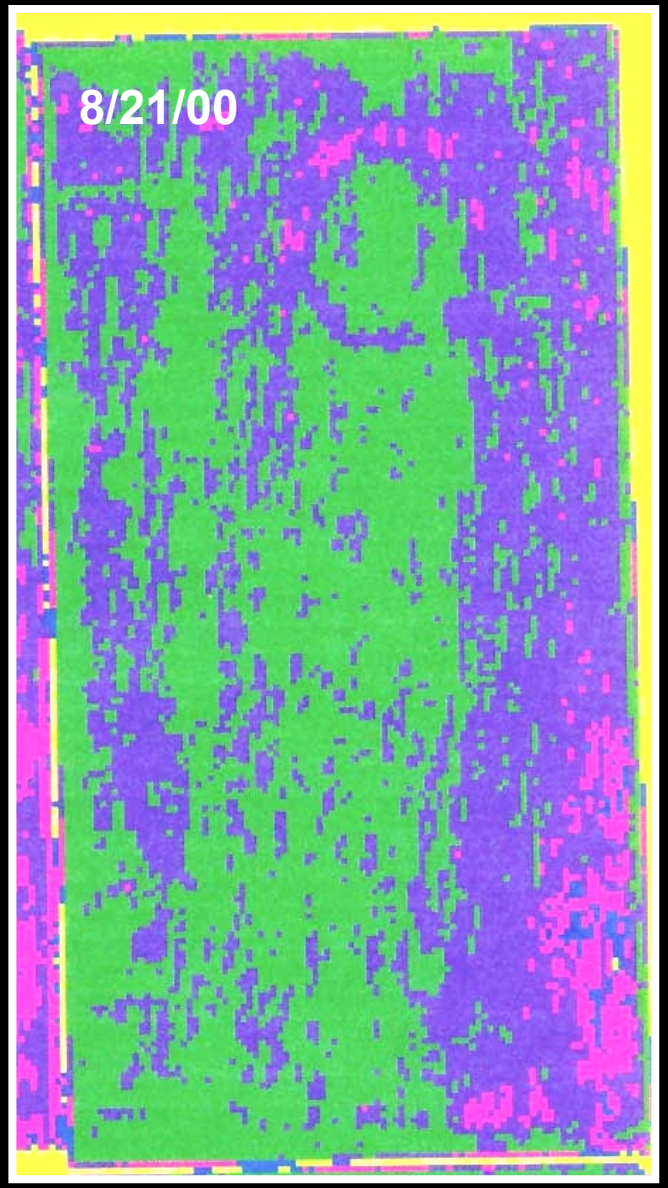
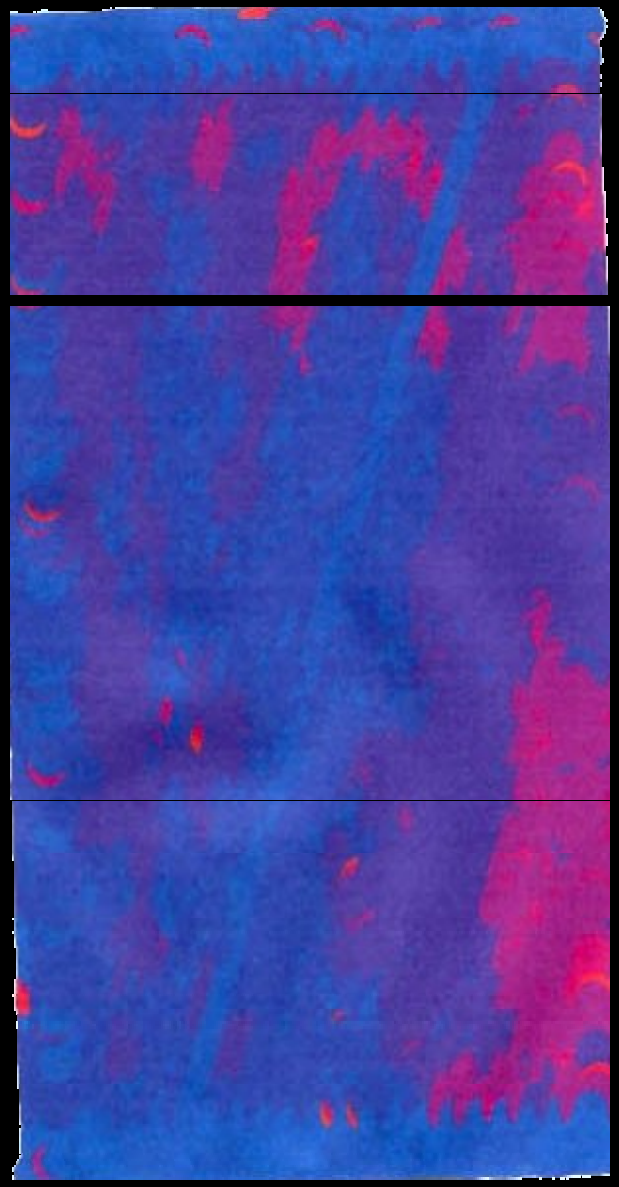
Zoning with High Resolution Imagery

Field #19

IKONOS derived NDVI





Actual Nitrogen Applicatio Map

75-100
100-125
125-150
150-175
175-200
200-225
225-250
250-275

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Imagery Based Zoning: Saving over 2 years

For Field #19 74 acres

Year 1 $270.84 Savings

Year 2 $661.56 Savings

Total Savings= $932.40

34.8% less nitrogen fertilizer applied

6342 less pounds of nitrogen fertilizer in the environment

Quality Improvement over 2 years

For Field #19 74 acres

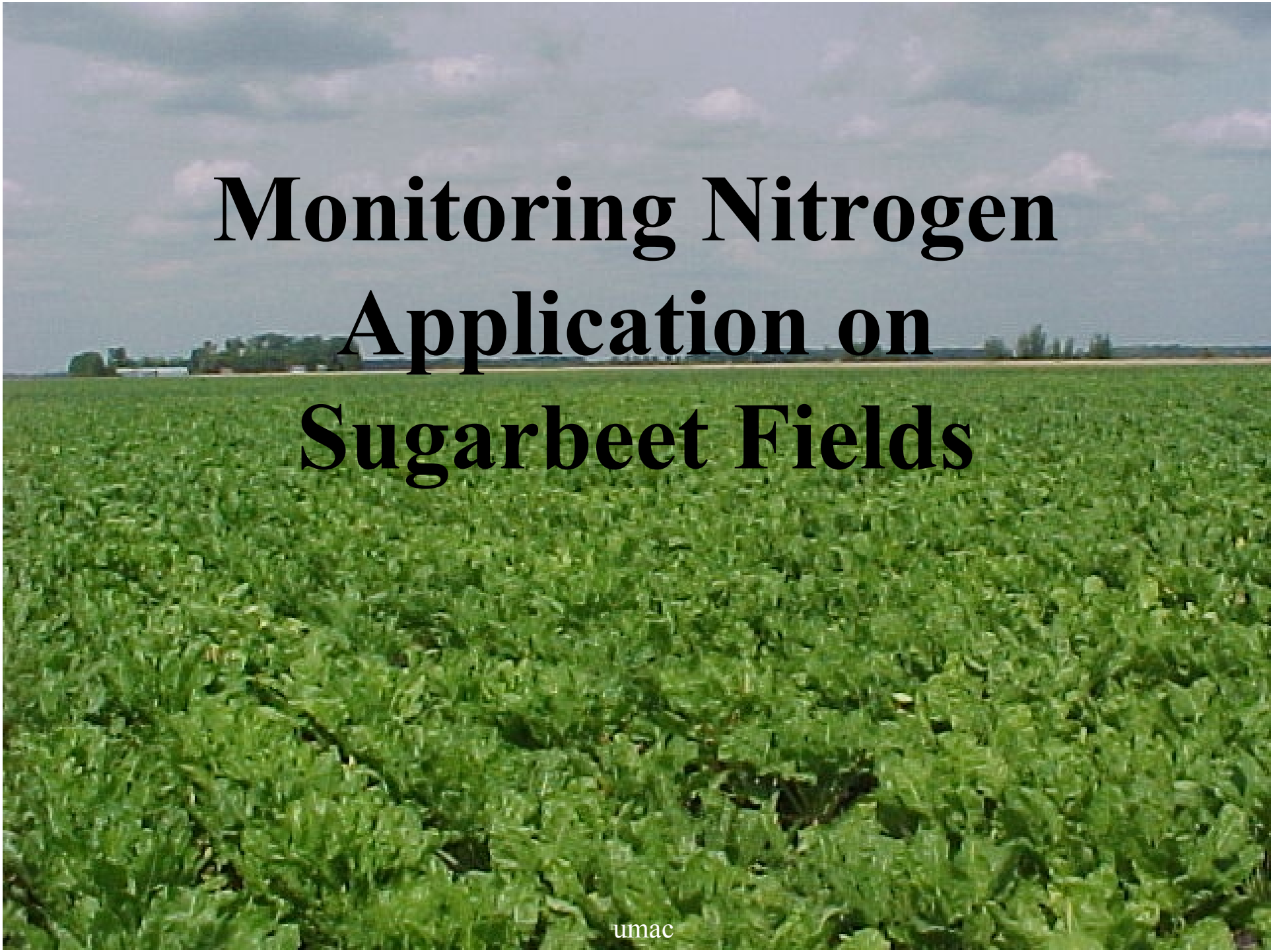
Yield / acre = +2.1 tons

Quality increase = 1% ($102.84 / acre)

Increased Revenue= $12,101.96

Total Saving Over 2 Years

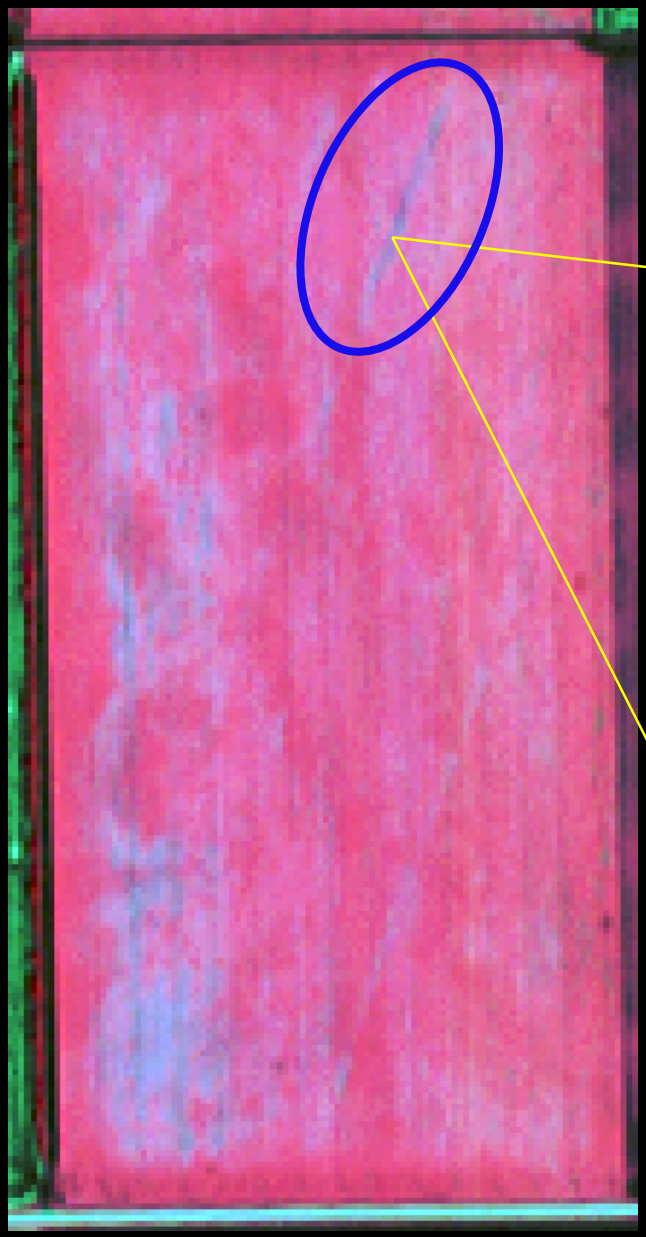
$13,034.36



Monitoring Nitrogen Application on Sugarbeet Fields

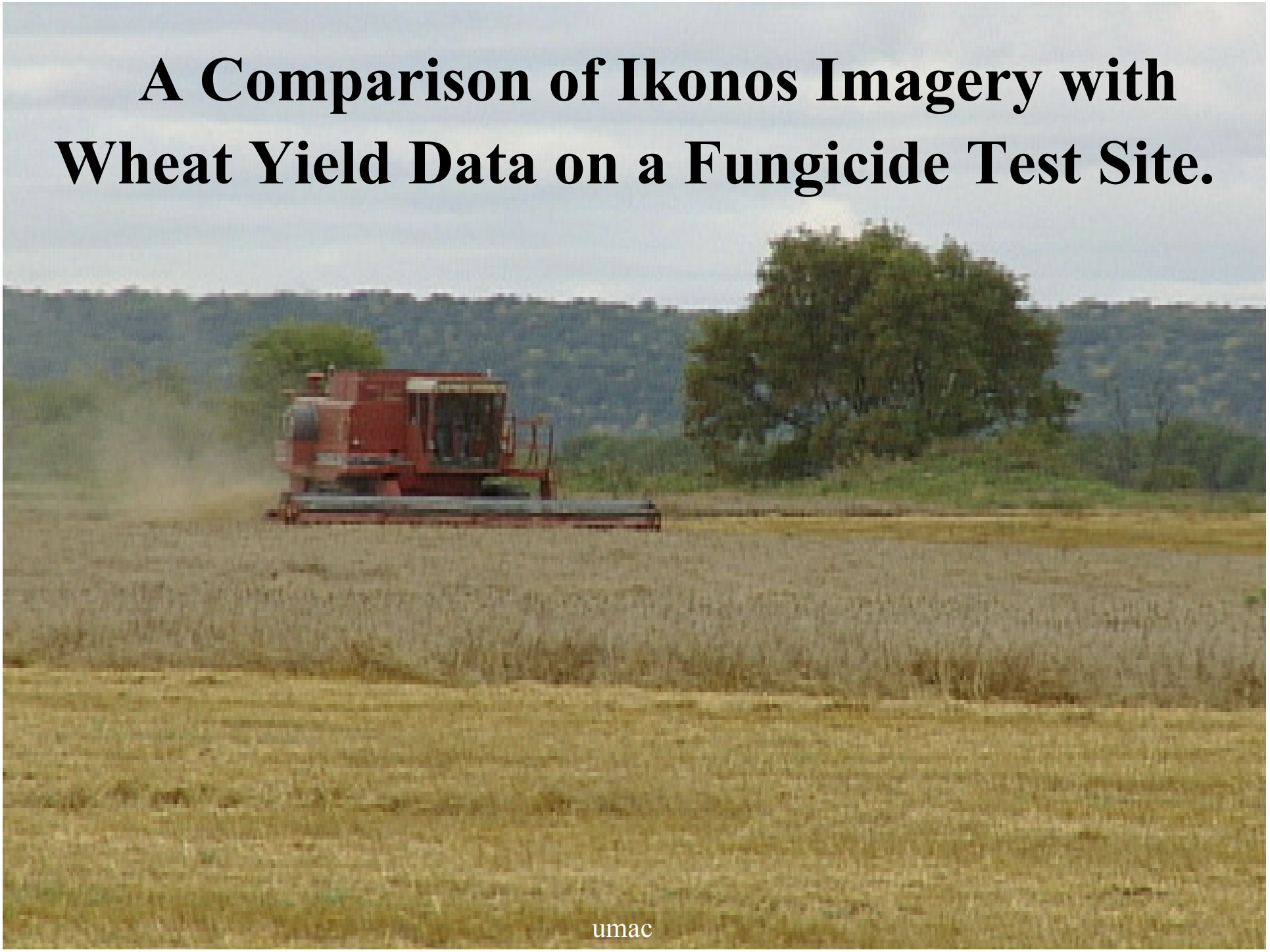
Nitrogen Check Strip

Applicator was shut off for a check



IKONOS Aug 21, 2000

A Comparison of Ikonos Imagery with Wheat Yield Data on a Fungicide Test Site.



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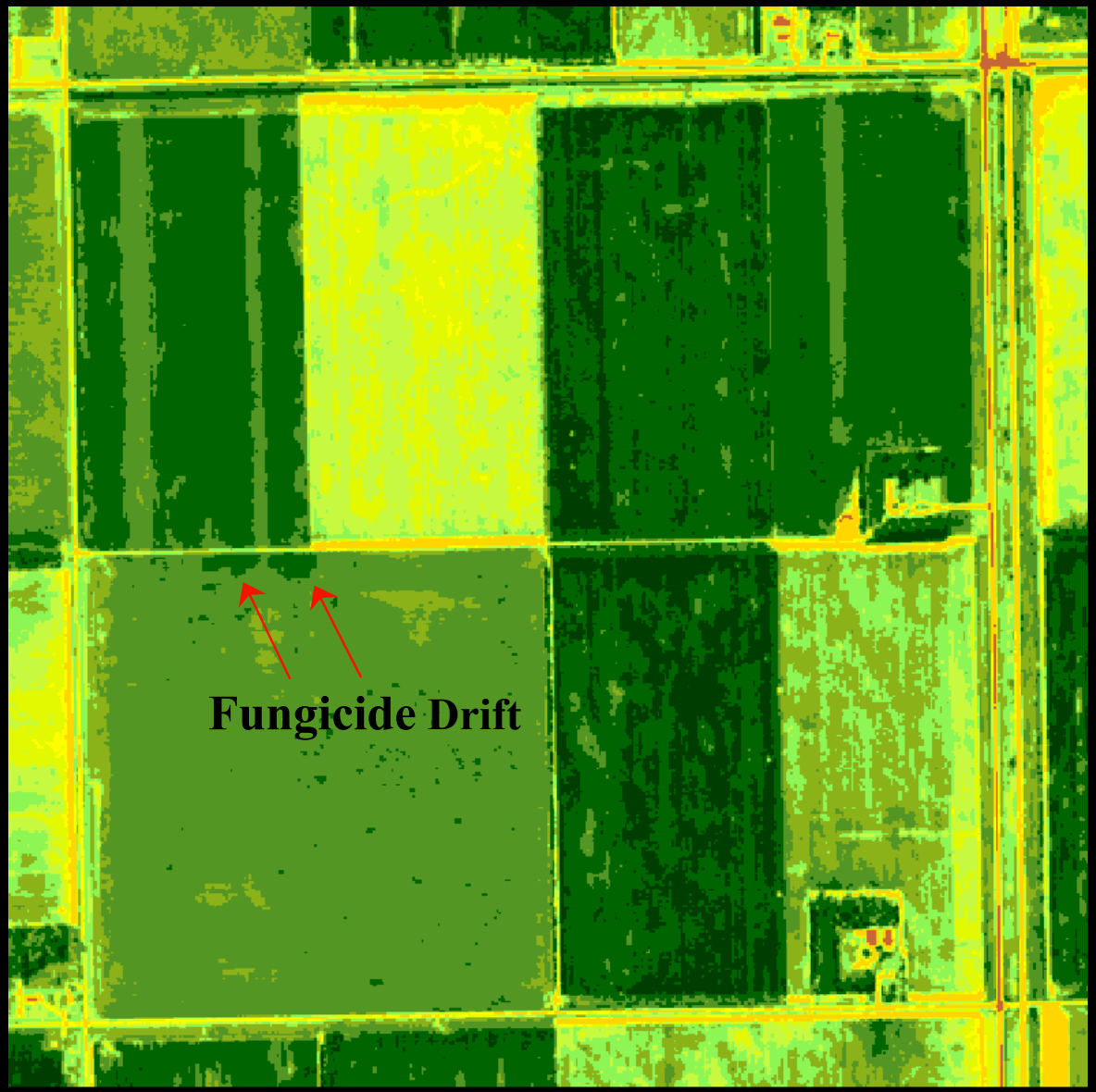
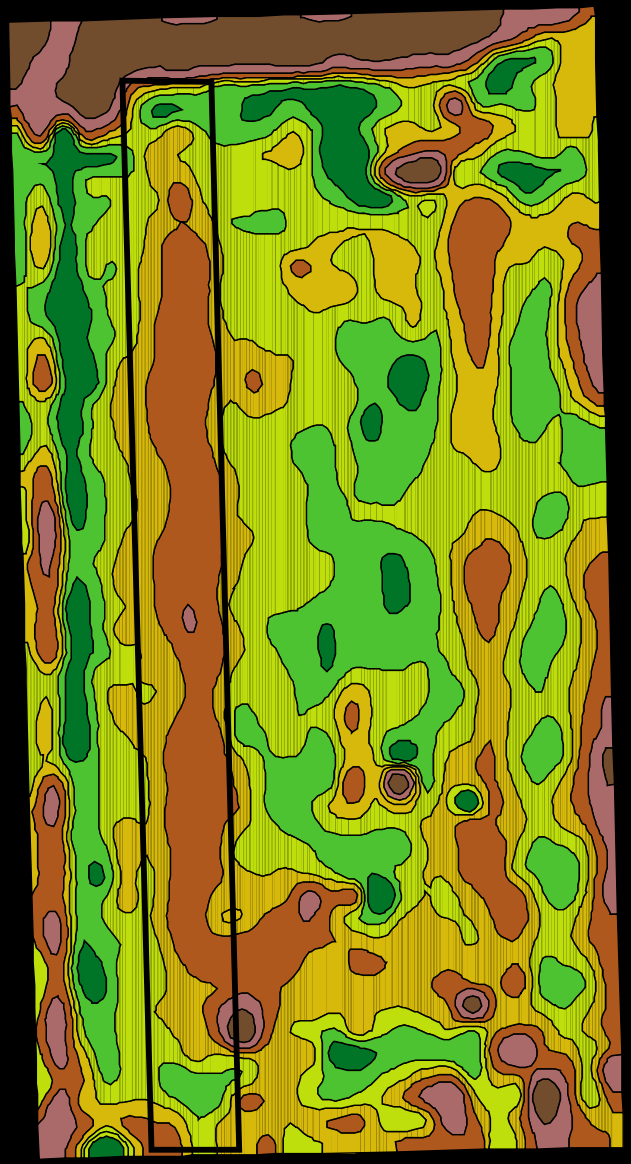
July 19, 2000 Subset from Ikonos Scene

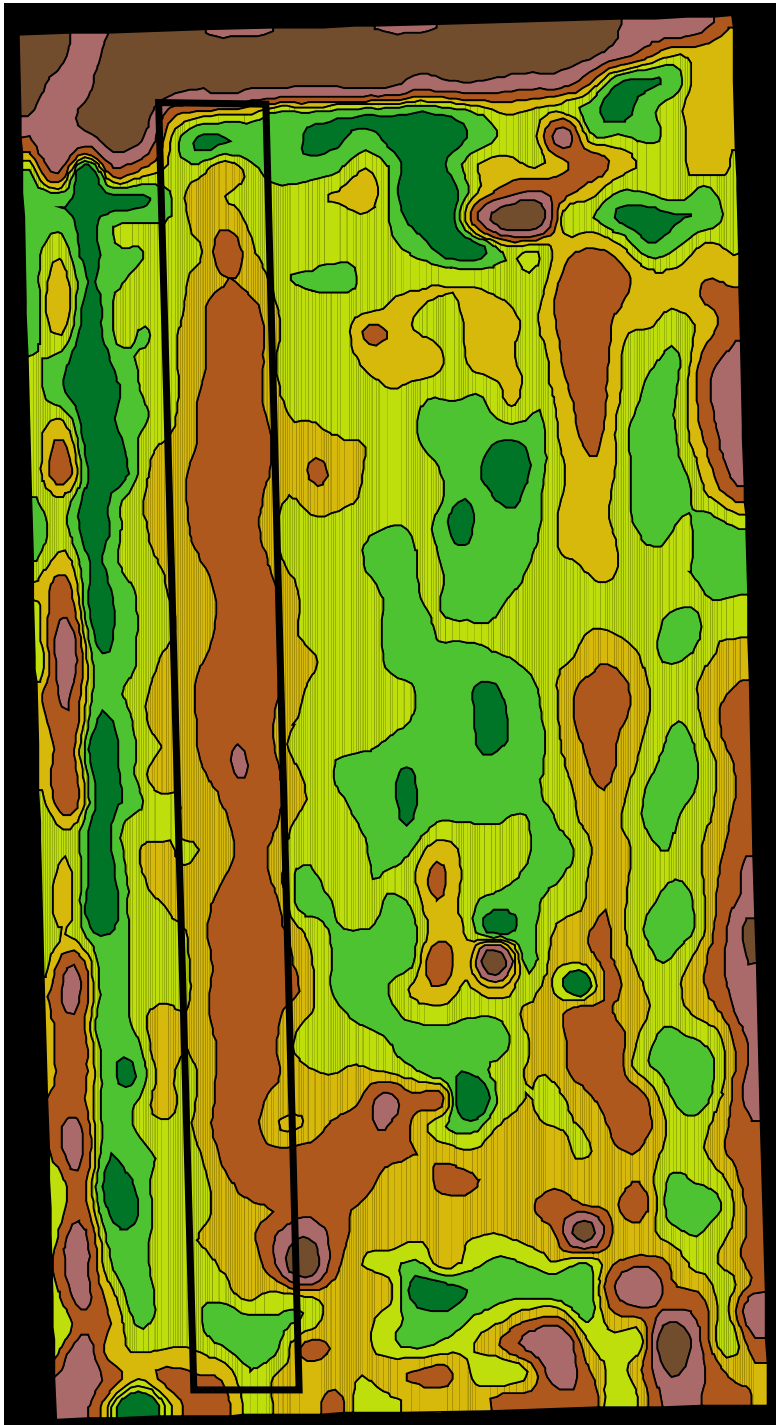
NDVI Derived from Ikonos Data



GPS Based Yield Map



Yield Overlay



Wheat Yield in Bushels per Acre

(1 bushel~35 liters)

Average yield inside the check strip: **61**

Average yield adjacent to the check strip: **72**

Yield (Bushels/Acre)

- 34.3 – 45.8
- 45.8 – 56.3
- 56.3 – 62.3
- 62.3 – 66.9
- 66.9 – 70.4
- 70.4 – 73.0
- 73.0 – 83.6

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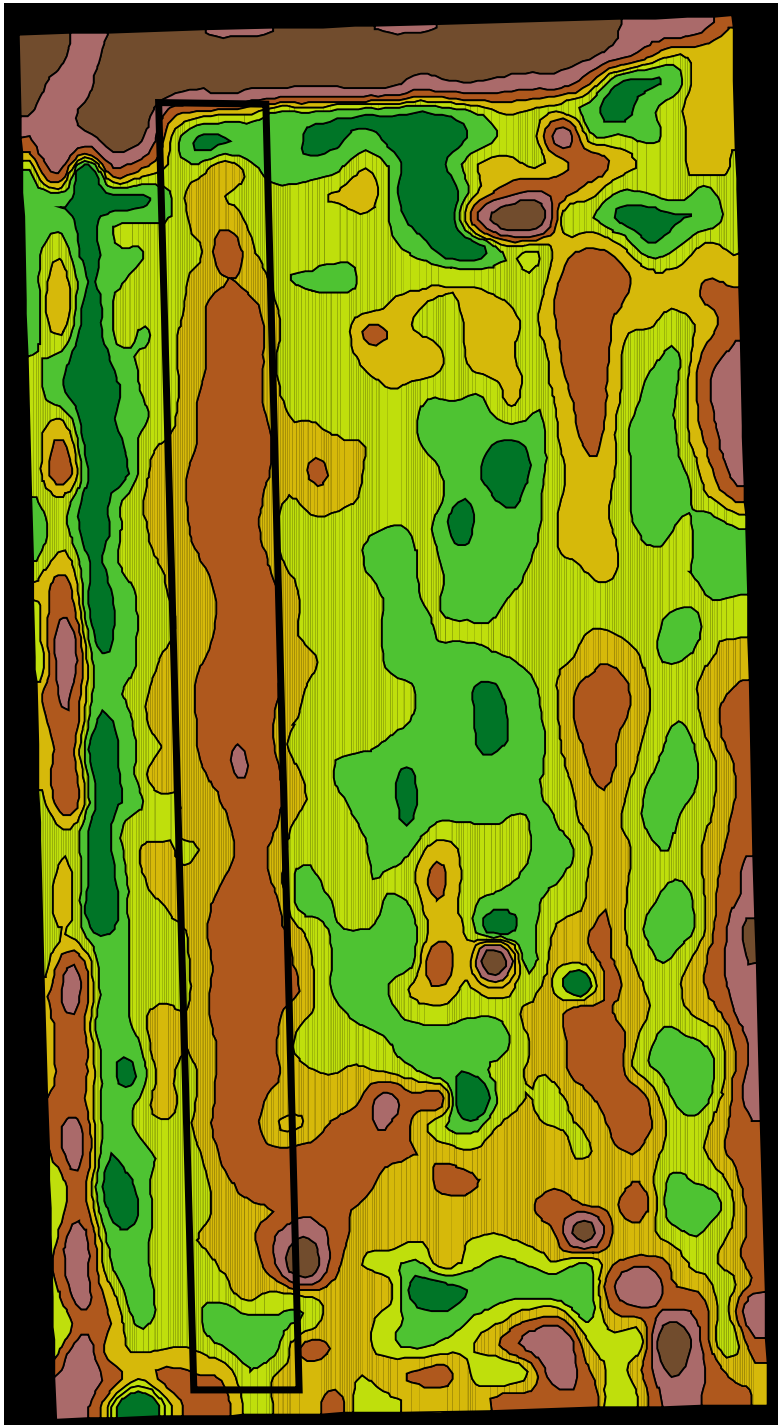


Fungicide Application Resulted in;

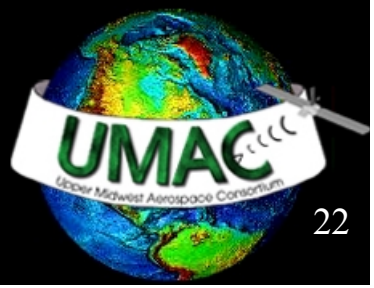
+$33/acre

or $2,640

Using NDVI to Select Acres to Destroy for Payment In Kind (PIK)

What is PIK?

- Due to overproduction of sugar, USDA introduced this program to reduce sugar inventories and thereby support prices.
- Farmers were allowed to destroy a limited sugarbeet acreage in return for payment.
- Farmers who participated wanted to maximize their returns by destroying least productive parts of their field.



PIK Acres … Where?

- Objective: Choose less productive acres to be destroyed for PIK
- NDVI from Ikonos showed several areas where plant vigor was lower
- Ground truth evaluation revealed that some beets were sick, whereas others were mature


Assessment of
Accidental Desiccant
Damage
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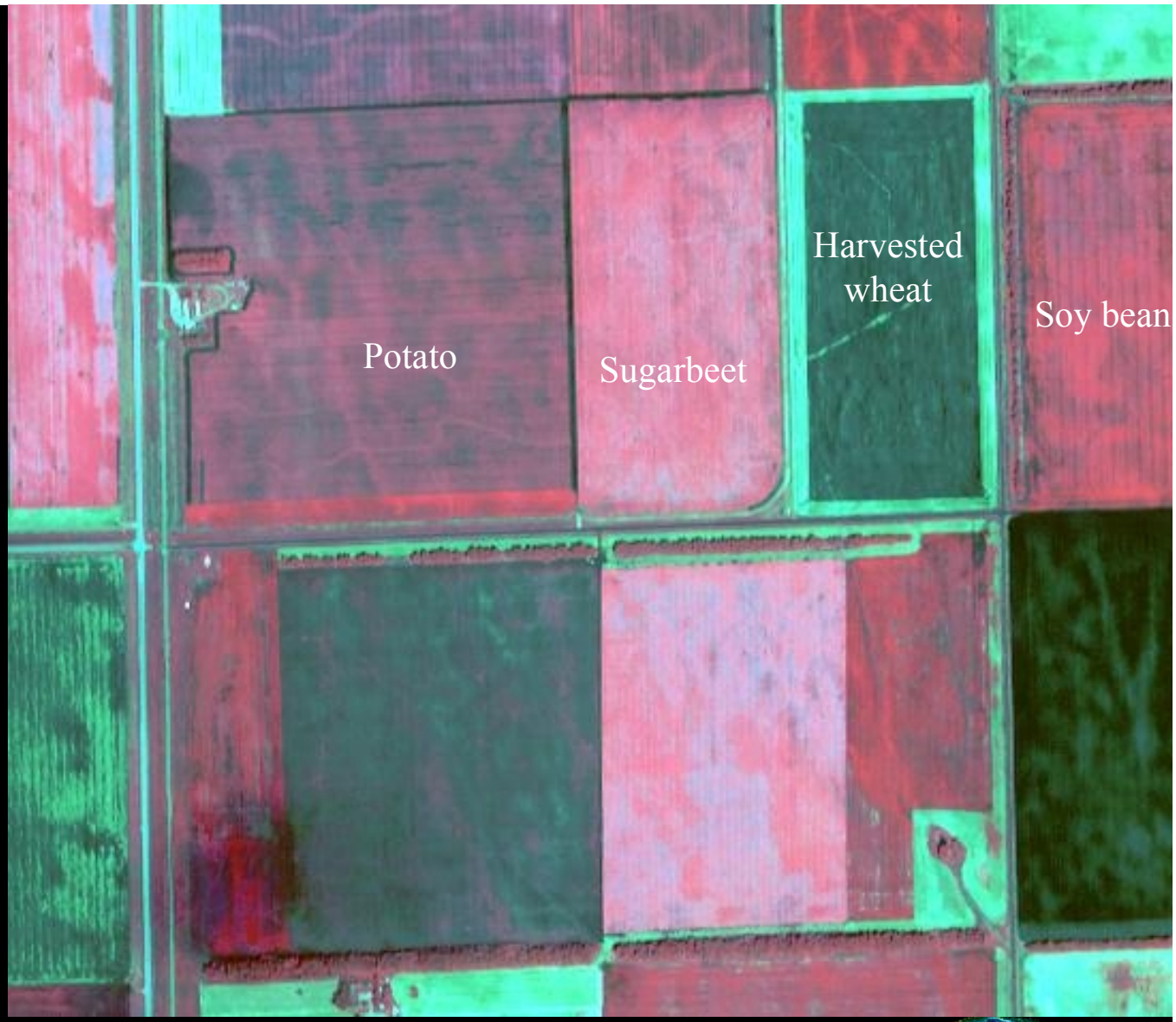
- **Potatoes and Sugarbeets grown side by side**
- **Both are high value row crops**
- **Both fit together well in a multi year rotation with other crops such as wheat**
- **Sugarbeets continue to increase in value throughout the growing season**
- **Sugarbeet harvest generally begins around the first of October**



IKONOS Imagery showing location of field

The Desiccant

- Typical desiccant is a contact type compound that kills green tissues, but does not affect the roots
- Ground sprayers or aircraft can be used to apply desiccants
- Ground sprayers are preferred, but aircrafts used for speed or when the ground is too wet
- Aerial spraying can result in errant spray drift
- Sugarbeets are usually at a very critical, last month at the time of the potato desiccant application.
- Sugarbeets are extremely sensitive to the defoliants

Why Desiccant?

- Potatoes generally mature more quickly than do sugarbeets
- They usually reach optimum size between late July and early September
- Potato vine desiccant is used to defoliate potato plants:
  - To stop growth of tubers to maintain desirable size
  - To accelerate the toughening of skins
  - To stop diseases from spreading
  - To facilitate harvest

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August 31st
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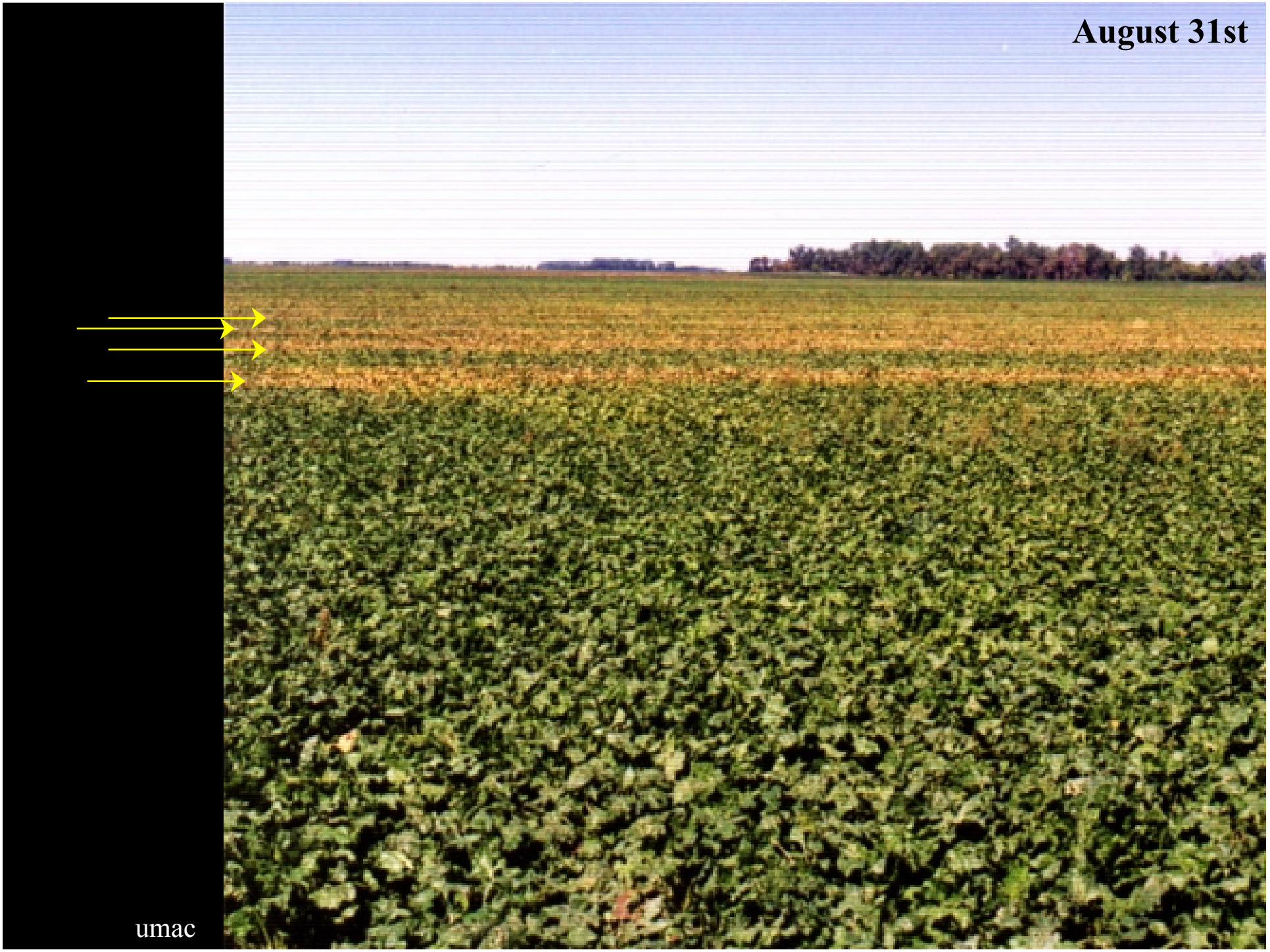
August 31st
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September 12th
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September 21st
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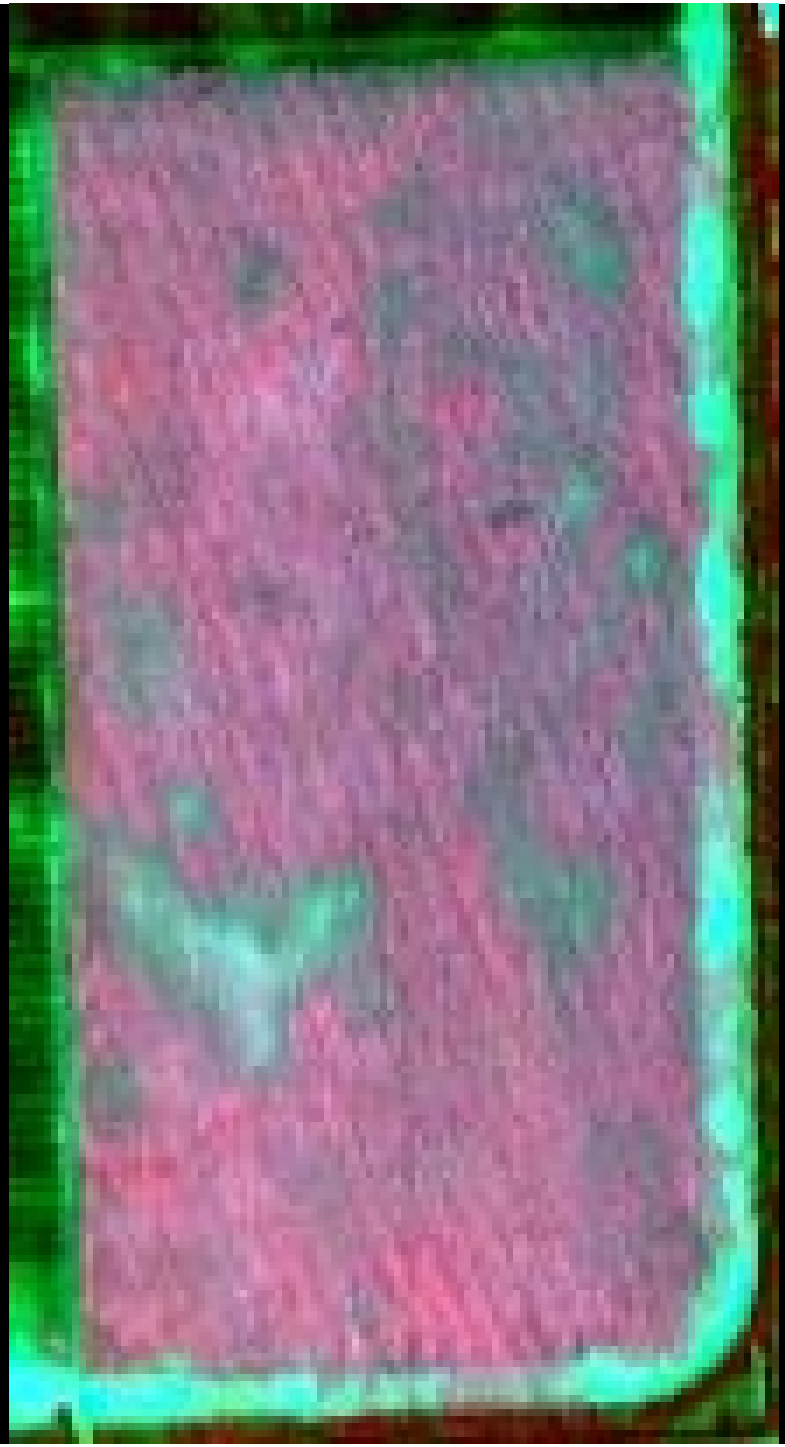
IKONOS image sub set showing the sugar beet field.

July 19, 2000

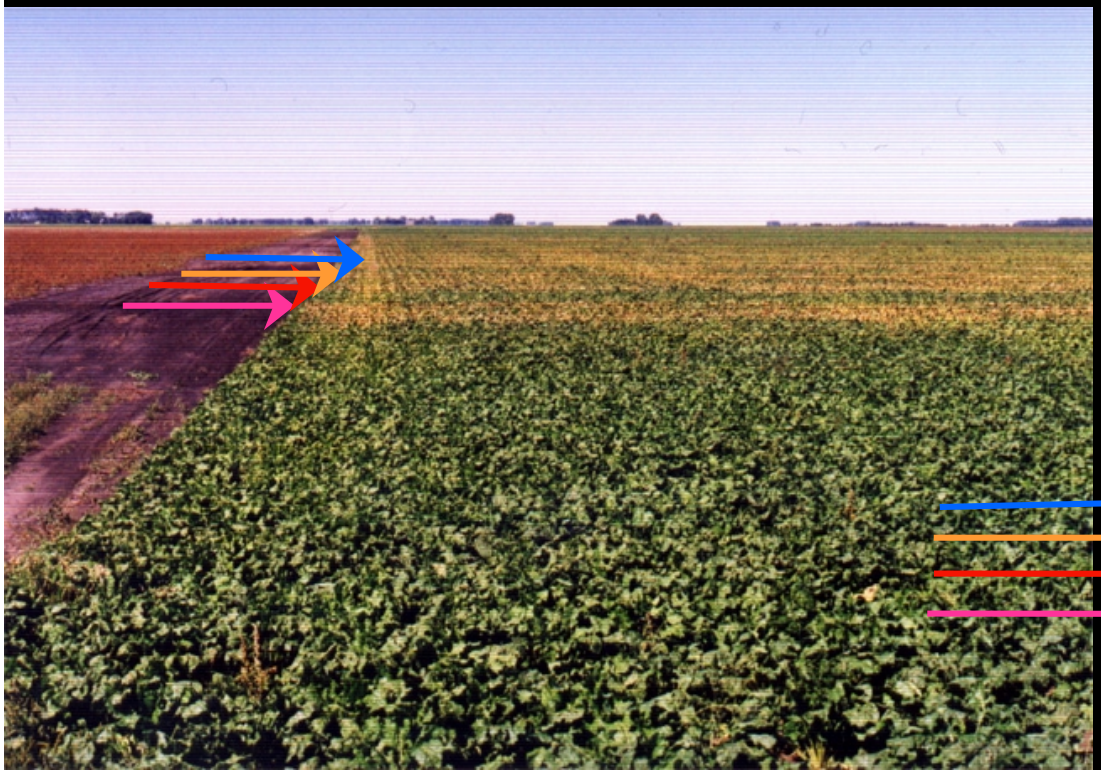


IKONOS image sub set of the field.

August 21, 2000

2 meter, multispectral, aerial image acquired by DIGIT Inc, on September 14, 2000

DIGIT Inc's aerial image of field, enhanced to show desiccant damaged areas.



Damaged areas shown in yellow lines.

Total area damaged estimated at 18.7 acres.

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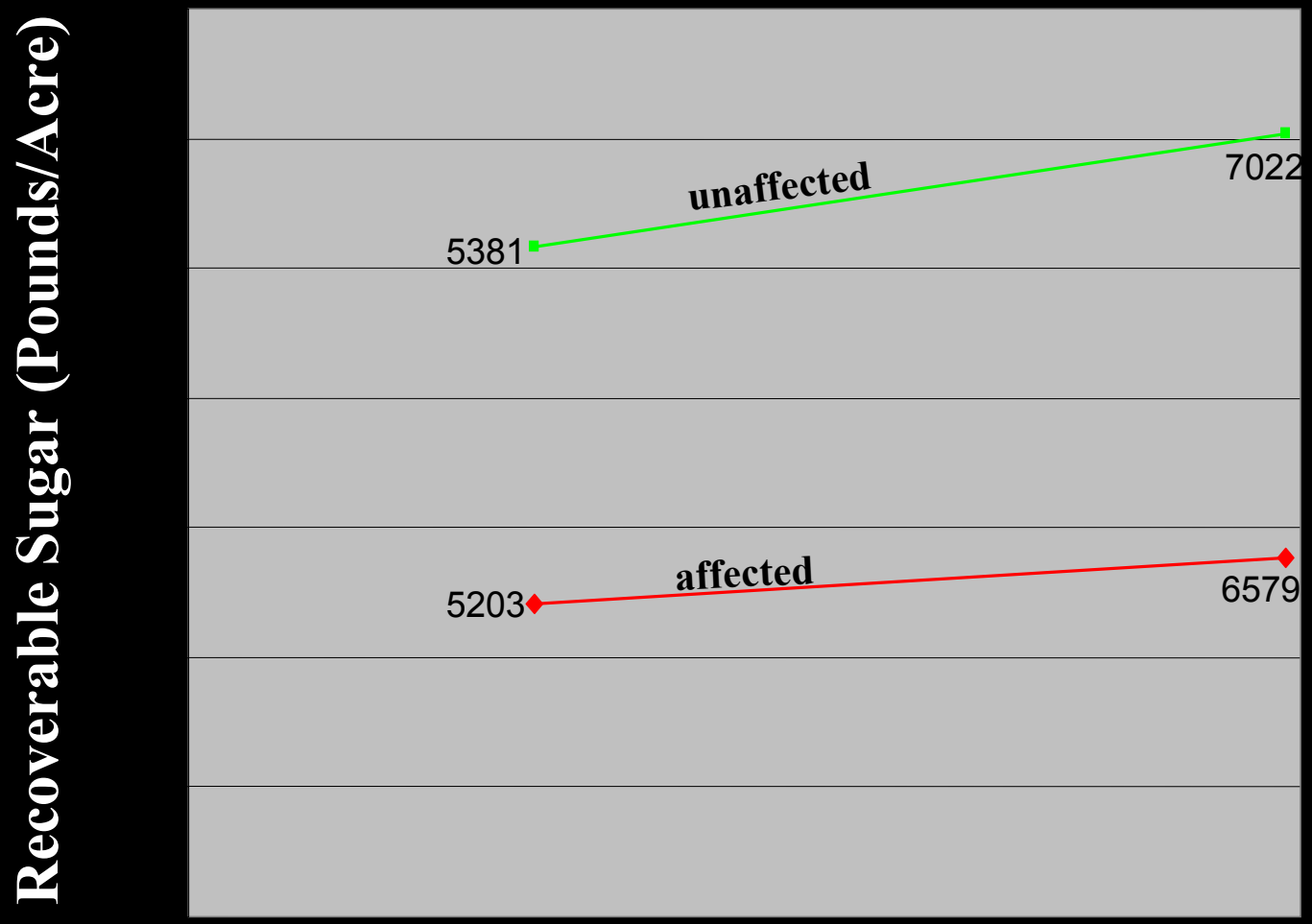
Recoverable Sugar: Unaffected vs. Affected Areas



The loss of sugar content due to desiccant damage was estimated at 443 pounds per acre. At $0.20 per pound, the total loss was estimated at $1657.

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Finally **the Last Slide!!**

- High resolution remote sensing for precision farming is
  - –Environmentally friendly
  - –Economically friendly
  - –*AND EVEN FUN!!!!*